bars and isotherms for the West Indies, the Caribbean Sea, and the Gulf of Mexico. Probably the most interesting station on this chart is that of Colon, at which point the observations give us clear evidence that the equatorial belt of low pressure on the Pacific Ocean here crosses over into the Caribbean Sea. There can be no doubt but that the flow of northerly winds over the United States is often due as much to a deficiency of pressure in the Caribbean Sea or in Brazil as to an excess of pressure in North America. The study of the equatorial regions is certainly quite as important to the meteorologist as the study of the polar regions, a phase of the question that was especially dwelt upon in 1881 when discussing the necessity of the great international polar work. It is to be hoped that the publication of these charts, which have been kindly prepared by Mr. A. J. Henry, will prove of great service in attracting attention to the meteorology of this portion of the globe. We have on many occasions explained in the MONTHLY WEATHER REVIEW how this eastern end of the Pacific trough of low pressure turns northward in the summer season and reaches into Arizona. In that Territory, as at Colon, the low pressure is not a direct result of local temperature, but is a feature that belongs to the general circulation of the atmosphere.

Beginning with the month of March we hope to be able to complete the western portion of this map by making use of the data published on the daily and monthly maps of the Mexican service.

THE AMERICAN METEOROLOGICAL JOURNAL.

The Editor has received from one of our voluntary observers, a request for Vol. I, No. 1 of the American Meteorological Journal, and not being able to supply this number, takes the liberty of making this request known, in hope that some one may have a copy to spare.

The librarian of the Weather Bureau would like to obtain Nos. 1, 2, and 3 of Vol. II.

Prof. H. A. Hazen would like to obtain a personal copy of Vol. II, No. 2.

In general, copies of Volumes IX–XII may be purchased of the publisher by those who wish to complete their sets.

VERTICAL TEMPERATURE GRADIENTS.

Mr. J. S. Hazen, voluntary observer at Springfield, Mo., notes a remarkable difference of temperature within 90 feet of the ground at that place on March 26. He says:

The station thermometer is located in its shelter, 90 feet above an extra thermometer, which latter was 3 feet above a level lawn. The following comparative readings were taken:

Time.	Thermometer.		
	In shelter, 93 feet above lawn.	3 feet above lawn.	Difference.
	°	°	°
9 a.m.	32.2	36.5	4.3
10 a.m.	33.0	37.4	4.4
11 a.m.	33.0	37.7	4.7
12 a.m.	33.3	38.5	5.2
1 p.m.	33.5	38.9	5.4
3 p.m.	35.0	40.6	5.6
4 p.m.	34.2	39.0	4.8
5 p.m.	34.0	35.1	1.1

The observer's attention was first called to the peculiar condition by noticing that the trees and various other objects were covered with a heavy coating of ice down to about twenty feet from the ground, while the lower branches of the trees and the surface of the ground was entirely free from any evidence of ice.

The night of the 25–26th was cloudy, with light fog early in the the morning and the day following. The humidity was high, and the air impressed one as being damp, heavy, and penetrating.

Two thunderstorms of slight intensity occurred during the 26th, one shortly before 11 a. m., and the other about 2 p. m., and both were accompanied by hail. The hailstones were about the size of peas.

The line of demarcation between the warmer surface air and colder air above was sharply and distinctly drawn, but the colder air gradually encroached upon the warmer body of air. It was noted that during the first hailstorm the ice remained in the sloping gutter of a shed roof down to about twenty feet above the ground, but after the second storm the ice was extended down to within less than ten feet from the surface of the ground, while lower than that no ice remained.

It is believed from the amount of ice on the trees that the temperature was probably lower at a height of about fifty feet from the ground than it was in the instrument shelter, but there was no way of taking the temperature at that elevation. Ice began to form on the ground shortly after 8 p. m.

It has been suggested that—

If the air at the surface of the ground was unusually dense, by reason of pressure and humidity, still the cold brisk breeze a hundred feet above the ground would force a mixture between the cold air above and the warm air below in a very short time. It is, therefore, considered by some as remarkable that the colder air above should have encroached so gradually upon the warm air below.

The Editor would remark that the question is not one of pressure or humidity but of temperature, and that our first consideration must be to ascertain the relative reliability of the observed temperatures at 3 and 93 feet, respectively, above the lawn. On this point a letter of inquiry was immediately addressed to the observer who replied:

The temperature was obtained from a standard Weather Bureau thermometer, which was attached to a small stake, driven into the ground. There was no covering or obstructions around the thermometer, but as the weather was densely cloudy, the exposure was deemed good. There was a clear lawn space around the instrument of at least 50 feet.

As this exposure of a thermometer is wholly unsatisfactory, it would be improper to attempt to draw any refined conclusions from the comparison of the upper and lower temperatures.

When questions of a few degrees Fahrenheit are propounded in meteorology, the method of determining the temperature of the air is of paramount importance. Every one who has examined the subject now recognizes the fact that a thermometer does not show the temperature of the air unless all injurious radiation has been annulled either by protecting screens or by a rapid flow of air, or by the rapid whirling of a thermometer. In the present case, it is quite plausible that the temperature at the level of the lawn between 9 a. m. and 5 p. m. was higher than at the level of the instrument shelter 93 feet above the lawn, but the amount of this difference in degrees can not be satisfactorily deduced from these observations. It is not likely that the true difference was very large because, as the observer states, the weather was densely cloudy. The only way in which this difference could be determined with an accuracy of one-half a degree Fahrenheit, would be by using standard thermometers at the upper and lower station, well screened against all radiations, and well ventilated either by the natural wind or by whirling them, as with a sling psychrometer, or by causing a rapid indraught as in the Assman psychrometer. A full description of the various methods of determining the temperature of the air is given in the Editor's Treatise on Meteorological Apparatus and Methods, published as Part 2 of the Annual Report of the Chief Signal Officer for 1887. Recent special investigations have been published by the Seewarte at Hamburg and the Meteorological Office at Berlin.

Errors of several degrees Fahrenheit are liable to be incurred when a thermometer is simply hung in the open air without protection from radiation and without special ventilating currents. In the present case if the trees and other objects twenty feet above the ground were covered with ice and the sun's rays did not penetrate through the thick clouds, we should naturally expect that streams of cold air from the ice would settle down to the ground, and that the temperature at 3 feet above the lawn would be as cold, if not colder, than

that at 93 feet above. But in fact there is always a strong radiation to the ground from a layer of cloud. The sun heats the upper surface of the clouds, and by convection the influence of this heat is felt at the lower surface, which latter is also warmed or cooled, as the case may be, by radiation between it and the ground. One may often notice how rapidly the ground dries up as the fog lifts, although the sun is still invisible. It is evident that something of this kind took place in the present case since the lower thermometer was warmer than the upper thermometer by a quantity that kept on increasing up to 3 p. m. and then rapidly diminished. The wind near the ground was too feeble to nullify the radiation from the lawn. It was much stronger at the 93-foot level. The upper thermometer gave the temperature of a general layer of wind; the lower thermometer had a temperature due to radiation from the lawn, and not necessarily the temperature of the lower air.

In conclusion we may say that this unusual difference of from 4° to 6° in a vertical distance of 90 feet, even if it were demonstrated by unexceptionable apparatus to really exist is not an *inversion*, as the observer called it, of the ordinary vertical temperature gradient. The ordinary gradient is defined as being a diminution of temperature with increasing height above ground, and that is what was recorded in the present case. An *inversion* is an increase of temperature with height above ground, such as occurs during a few hours in the early morning under a clear sky, and especially when hoar frost is deposited from still air.

When the vertical gradient is a diminution at the rate of 1° C. for 99 or 100 meters, or 1° F. for 183 or 187 feet, this is called the adiabatic gradient and the air is said to be in a state of neutral equilibrium, because a mass of it raised or lowered by any number of feet will be cooled by expansion or warmed by compression to such an extent as to have the same temperature as the surrounding air in its new locality; hence the air whose location has thus been changed has no tendency to move from the place to which it has attained. On the other hand, if the rate of diminution with ascent is greater than 1° for 187 feet, as in the present case, where it was, at 3 p. m., 1° for 16 feet, then the upper air has a tendency to descend, and the lower air a tendency to ascend and to keep on ascending or descending indefinitely, so that the air is said to be in a condition of unstable convective equilibrium, such as occurs in the hotter portion of every clear day near the surface of the earth.

If the rate of descent is less than 1° for 187 feet, and especially if it becomes negative, that is to say, colder below and warmer above, then the air is in a state of stable equilibrium, and if raised or lowered tends to return to its original position.

UTILIZATION OF FOG.

On page 101 of this number of the MONTHLY WEATHER REVIEW we publish an interesting article by Mr. A. McL. Hawks, C. E., of Tacoma, Wash., on the subject of the utilization of fog for irrigation on the coast of southern California. His communication was suggested by the remarks of the Editor, published in the MONTHLY WEATHER REVIEW for October, 1898. Mr. Hawks states very truly that expensive mechanical means for collecting the fog will not be practicable. Indeed, the Editor substantially said the same thing in October, and suggested that some simple method be devised for catching the fog and forcing it to drip to the roots of the plants as useful water.

The use of liquid air, as suggested by Mr. Hawks, would undoubtedly be one of the most expensive methods of catching the fog and there is room for grave doubt whether any fog at all could be condensed by its use. Liquid air is the remarkable product of a powerful steam engine and appropriate apparatus. When manufactured, even on a large scale, it is not likely to cost less than 25 cents a gallon or to be sold for less than double that price. If one simply needs to have a cooling agent in order to condense the fog into drops, one might, far more economically, make use of artificial ice or the original brine bath and the ammonia coils of a refrigerating apparatus. The evaporation of liquid air back into the free atmosphere, which is the experiment that is now being daily shown to hundreds of people, does not produce the least sensible influence on the temperature of the audience chambers where the experiments are performed and would have still less effect over the orchards of southern California.

Mr. Hawks suggests a second method for attacking the problem, viz, the construction of a flue or smokestack leading from the cooler air above the fog down through the warm air to the earth's surface, in order that the cold air may descend through it to the ground. But the upper cold air really does not need any such conducting flue, it will descend of itself if the conditions are proper; otherwise, it can not be brought down except by the use of some extraneous expensive force and if brought down would be warmed up so much by the compression due to the greater barometric pressure near the earth's surface that it would not produce rain, but become a veritable warm, dry chinook.

But there is a third and most valuable suggestion in the letter of Mr. Hawks. He has observed that shiny black-painted iron or shiny freshly painted boards exposed horizontally are great moisture gatherers. It is evident from his statements that a concave painted board or a concave sheet or trough of painted iron will collect much moisture. If such a concave surface has a gentle inclination toward the ground, the moisture should drip in a steady stream all night long from the lower end, and can, therefore, be gathered in reservoirs or pails or led directly to the roots of the plants. This drip, as we stated in the October REVIEW, is that which maintains the verdure of Green Mountain on the Island of Ascension. It is well worth while for the agriculturists of southern California to follow out this line of experiment in the matter of utilizing the fog.

THE BLUE COLOR OF THE SKY.

The March report of the Montana section contains an interesting article by A. H. Thiessen, on the cause of the blue color of the sky. This was first explained by Rayleigh as probably due to the so-called selective reflection of the blue light in a beam of sunshine by the finest particles of aqueous vapor and dust. Mr. Thiessen gives a very simple statement of Rayleigh's explanation and we quote the following from his article:

> On a cloudless day when looking away from the sun toward the sky we observe its blue color. We are then looking into space, but our line of sight is intercepted by a multitude of dust particles suspended in the air. The color of these particles is observed to be blue. This is due to their reflecting to our eyes the blue rays against which they form an effective barrier, while the red or coarser waved rays pass on.
>
> The color of skylight is due then to the reflection of the shorter wave lengths to the eye. The air itself has no power to reflect light, but it contains innumerable dust particles which present a vast reflecting surface to the light waves. That the dust reflects back only the blue rays is due to their microscopic size. The finer the dust then the purer is the blue which is reflected or scattered. One may expect then to find the bluest skies in those places where the dust particles are smallest, and it is true that the blue of the sky as seen from the tops of mountains is deeper and purer than that seen from a lower altitude. This is due to the fact that the air is very rare at great heights and can only sustain the finer particles of dust, while the coarser particles abound at the lower levels. The sky of Italy is noted for its clearness. The blue is deeper, not because the dust there is finer than in the northern countries, but because in the countries of the north, due to the greater